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Research Letter

RESEARCH LETTER – Pathogens & Pathogenicity

Allicin from garlic inhibits the biofilm formation and urease activity of *Proteus mirabilis in vitro*

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One sentence summary: Allicin from garlic inhibits the growth, biofilm formation and urease activity of *Proteus mirabilis in vitro*.

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ABSTRACT

Several virulence factors contribute to the pathogenesis of *Proteus mirabilis*. This study determined the inhibitory effects of allicin on urease, hemolysin and biofilm of *P. mirabilis* ATCC 12453 and its antimicrobial activity against 20 clinical isolates of *P. mirabilis*. Allicin did not inhibit hemolysin, whereas it did inhibit relative urease activity in both pre-lysed (half-maximum inhibitory concentration, IC50 = 4.15 μg) and intact cells (IC50 = 21 μg) in a concentration-dependent manner. Allicin at sub-minimum inhibitory concentrations (2–32 μg mL^{-1}) showed no significant effects on the growth of the bacteria ($P > 0.05$), but it reduced biofilm development in a concentration-dependent manner ($P < 0.001$). A higher concentration of allicin was needed to inhibit the established biofilms. Using the microdilution technique, the MIC90 and MBC90 values of allicin against *P. mirabilis* isolates were determined to be 128 and 512 μg mL^{-1}, respectively. The results suggest that allicin could have clinical applications in controlling *P. mirabilis* infections.

Keywords: allicin; *Proteus mirabilis*; antimicrobial; urease; hemolysin; biofilm

INTRODUCTION

Proteus mirabilis, a member of the Enterobacteriaceae family, is one of the leading causes of urinary tract infections (UTIs) in patients with indwelling catheters or structural abnormalities in the urinary tract (Coker *et al*. 2000). *Proteus mirabilis* UTIs are most commonly associated with urinary tract obstruction, blockage of urinary catheters, bladder and kidney stone formation, and bacteriuria. Intrinsically, *P. mirabilis* UTIs are often persistent and difficult to treat (Rozalski, Sidorczyk and Kotelko 1997). Furthermore, the development of extended spectrum beta-lactamase producing and multiple drug resistant strains of *P.* mirabilis (Mokracka, Gruszczynska and Kaznowski 2012; Kurihara *et al*. 2013) have made treating *P. mirabilis* infections more difficult. Therefore, finding antibiotics with new modes of action and alternatives to commonly used antimicrobial therapies for

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